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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

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THIS ISSUE

Rock Drill Lubrication in Quarry and Mining Service

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LUBRICATION RECOMMENDATIONS FOR MINE AND QUARRY DRILLING

ROCK DRILLS, STOPERS AND DRIFTERS

Valves, Pistons, Rotating and Reciprocating Elements:

Oil Lubricated—Dry Air	TEXACO ALGOL OIL OR TEXACO URSA OIL
Oil Lubricated—Wet Air	TEXACO ALEPH OIL C-10 OR TEXACO DOLPHIN OIL
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Rock Drill Lubrication in Quarry and Mining Service

COLD weather operation imposes a severe load upon any lubricant which may have to function under exposed conditions. In no class of service are these conditions more exacting than in quarry and mining operations where ice, snow, water, dust and mud must be so often encountered. Men and machinery suffer under such intensive conditions; the former, however, can seek some relief under cover; machinery has no recourse, but must depend solely upon lubrication for the protection of its moving parts. This of course places a most exacting duty upon all lubricants employed, for any suggestion of congealment or inability to flow readily may remove that element of protection so essential to machinery in cold weather.

In the northern states and the colder countries of Europe, winter-time lubrication of pneumatic tools in quarry and mining operations must be carefully studied. Those finer parts such as comprise the working elements of drills, rock hammers and other pneumatic tools, along with close clearance mechanisms require especial consideration for the least resistance imposed upon their free motion may lead to serious increase in power consumption with loss in efficiency and the tendency towards wear.

Rock drill lubrication in mining and quarry operations also requires careful consideration due to the fact that effective use of air has a direct relation to the power bill. In cold weather the selection of suitable lubricants for drills and other types of air tools which may be exposed to the elements is especially important, for low temperature increases the resistance to flow thereby rendering petroleum lubricants more sluggish and less likely to reach all the mechanisms in certain types of tools. Hence the importance of low pour test and relative viscosity in predicting to what extent this may occur.

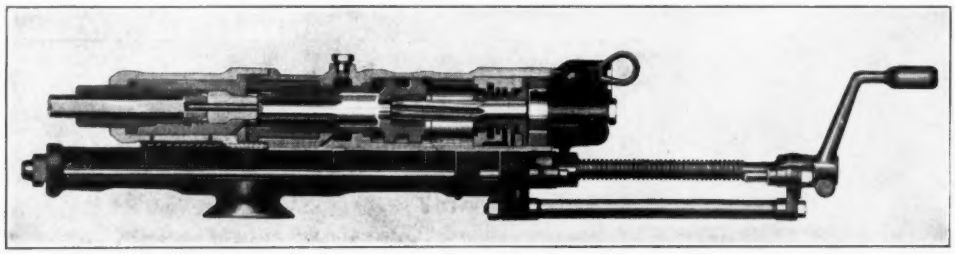
Tool designers have progressed markedly in their studies of ways and means to insure rock drill protection through dependable lubrication. They have given particular attention to lubricator construction and protection of all mechanisms by oil tight seals which not only prevent leakage of lubricant but also entry of abrasive foreign matter. This latter may be especially harmful to parts if it works into the mechanisms in that it will promote wear, cause increased clearances, and bring about noisy operation with marked decrease in efficiency. So thorough understanding of design lubricator application and the physical limitations of rock drill lubricants will be especially helpful to the operator of mining or quarry machinery.

PRINCIPLES OF OPERATION

A rock drill is a mechanical device, portable in nature, self-contained in regard to its propelling and operating mechanisms, and functioning by the energy resulting from the expansion of compressed air. The basic purpose

of a rock drill is to supplant the tedious and more or less unsatisfactory method of manual labor with the far more rapid and efficient method of automatic production. This is accomplished by subjecting the working end of the tool to percussion or rapid hammering,

As commonly understood, the rock drill is a percussion type of tool containing a piston which moves back and forth within a cylinder, striking rapidly upon the head of the drill steel which is held in the chuck. The design is so planned as to bring about rotation of the drill



Courtesy of Gardner-Denver Company

Fig. 1—The Gardner-Denver D-89 Drifter Drill as designed for general mine and tunnel work. An integral lubricator supplies lubricant to all parts of the machine. A chamber surrounding the front cylinder liner serves as a reservoir from which the lubricant is fed to the rear end of the cylinder.

constant pressure, or, in some cases, a combination of pressure and rotation. Where percussion is employed, air pressure acts on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. In other words, the tool mechanism involves a cylinder with suitable companion piston and valve arrangement for the admission of air at the proper time, according to the number of strokes per minute or percussive frequency required.

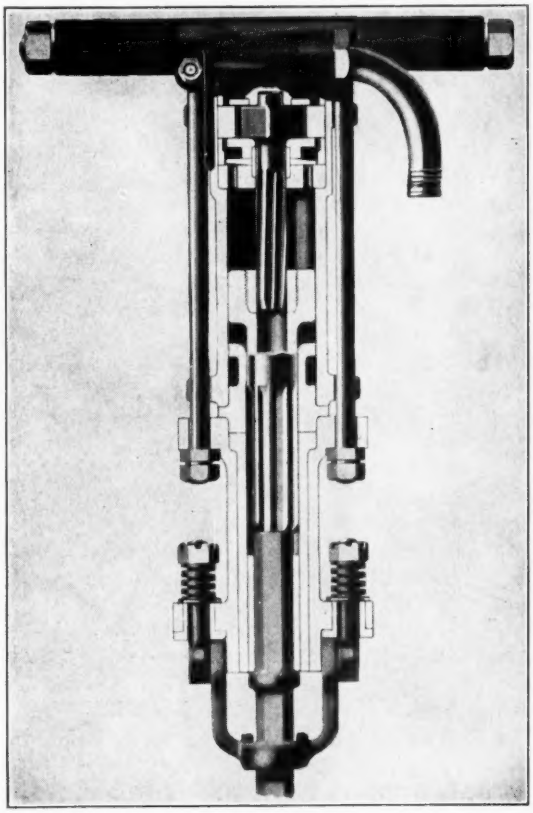
Two sets of valves are normally involved; i.e., the throttle valve whereby the operator is able to control the amount of air admitted and the working valve, which, through suitable timing, control the frequency with which the air pressure is allowed to react on the piston.

From the viewpoint of wear, the rock drill can therefore be likened to the reciprocating engine. In the matter of lubrication, however, and the reduction of this potential metallic wear between cylinder walls and pistons, etc., an opposite consideration is involved. Instead of relatively high temperatures as in a heat engine, low temperatures must be dealt with. Steam in its expansion gives off heat; petroleum fuels in their combustion develop heat; air, however, in its expansion and passage through pneumatic tools, absorbs heat from its surroundings. In consequence, this expansion temperature may be quite low. So, rock drill lubricants must be able to stand low temperatures and flow positively to all parts.

DRILL CONSTRUCTION

To enable better understanding of the lubricating requirements involved in rock drill operation, consideration of drill design and the principles of construction of the working elements is necessary.

steel at the same time. Compressed air affords the medium of operation of this piston; the speed and pressure, of course, being de-

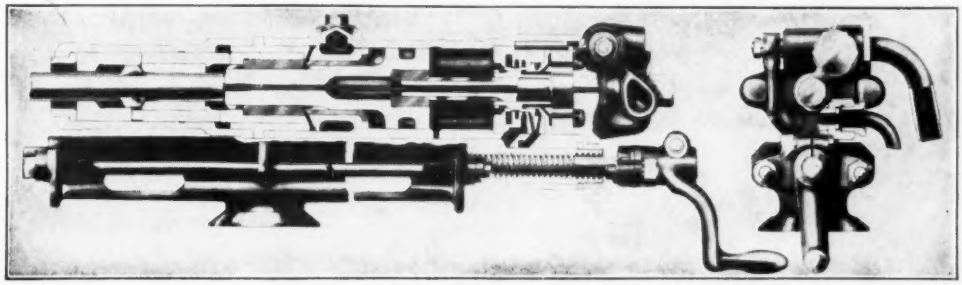


Courtesy of Ingersoll-Rand Company

Fig. 2—Cross sectional view of the Ingersoll-Rand "Jackhamer", showing the general construction and relation of the working parts.

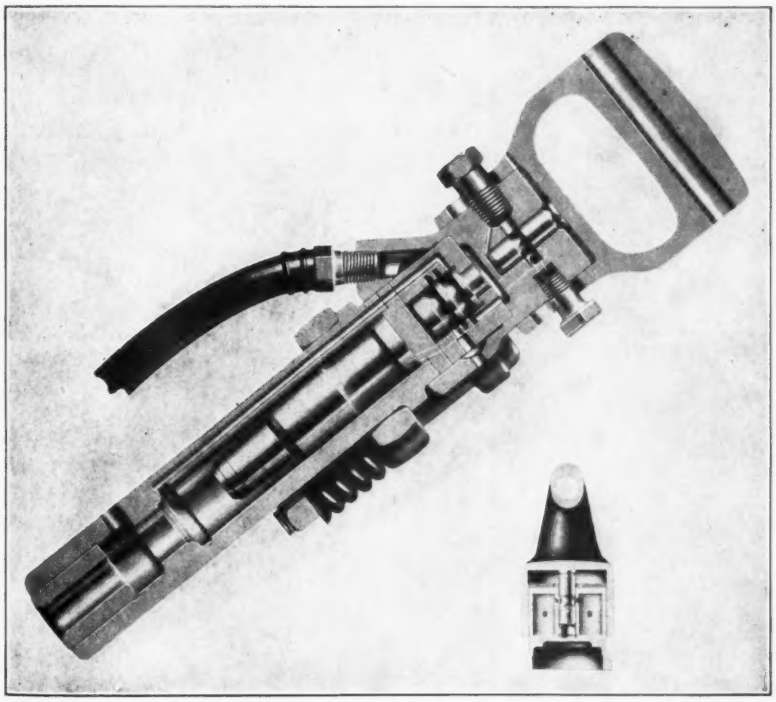
pendent upon the pressure of the air received from the compressor and being controlled by a suitable valve. Rock drills, as applied to quarry and mining operations are of a number

of types, according to the work to be accomplished. The hammer type of drill, as used for bench work or secondary drilling, is generally applicable to down-hole work. The rock-hammer or jack-hammer type of drill may be either comparatively light in design and capable of hand operation, or it may be so heavy as to require mounting on a tripod or column for mining operations, or on a wagon mounting for open work.



Courtesy of Chicago Pneumatic Tool Co.

Fig. 3—The Chicago Pneumatic type of Drifter. In this type of drill the entire mechanism is lubricated from one oil chamber, although provision for an air line oiler installation is also practicable. The feed screw is automatically lubricated by auxiliary exhaust.



Courtesy of Sullivan Machinery Company

Fig. 4—The Sullivan DH-4 Drill and oiler mechanism, showing compactness of design and relation of interior parts.

Drills designed for horizontal drilling are essential in mining and tunnel driving service. Normally they are known as "drifters." Where upward drilling is necessary, in turn the drill is termed a "stoper." The drifter drill is normally mounted on a column or tripod. On the other hand, the drifter type of drill can also be mounted on a portable rig, when it is known as a "wagon drill."

Rock drills may be designed for either wet or dry drilling, according to the type of service. In the operation of the "Stoper", or any other type of drill employed in angular or upward drilling in tunnel operations, it is extremely important to reduce the amount of dust in the interest of improving working conditions and reducing personal hazard among the drill runners.

Wet drilling, whereby a certain amount of water is injected under pressure into the hole being drilled through the drill steel, has been found to effectively accomplish the desired results. In addition, a certain amount of the exhaust air after it has done its work will pass out through the hollow drill steel. This exhaust air, along with the water, is of added assistance in removing cuttings.

The construction of a drill for wet drilling calls for a tube extending from the back head through the rifle bar and piston, and thence into the hollow drill steel. Through this tube the water is pumped under pressure.

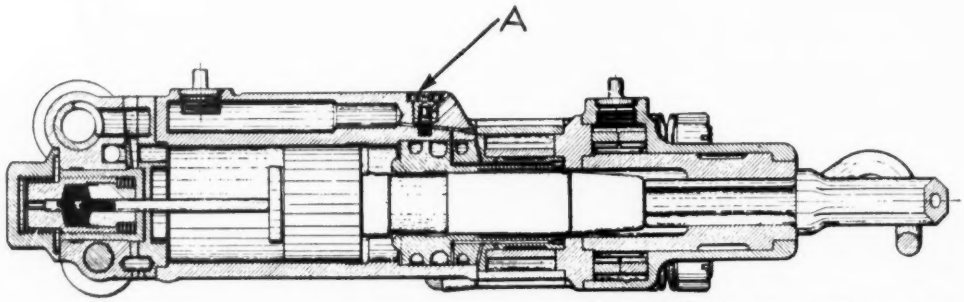
Drills of the hammer type, designed for down-hole quarry or excavation work, on the other hand will very often employ air alone instead of water for removal of cuttings, especially where damp rock is being drilled.

Relative to lubrication, those parts which

must be considered include the cylinder housing, the reciprocating piston, the valve mechanism and the front head which houses the chuck and rotative element. The main moving parts, of course, are the piston, valve and rotating chuck. Movement of this latter is, of course, controlled by compressed air through the medium of the piston. According to design, however, this rotative impulse may be derived either from the piston to which it is splined, with the piston in turn working on a rifle bar with a pawl ratchet attachment, or an independent balanced air motor may be located in the front head and connected directly to the chuck parts. In this case, of course, the piston is a free floating member.

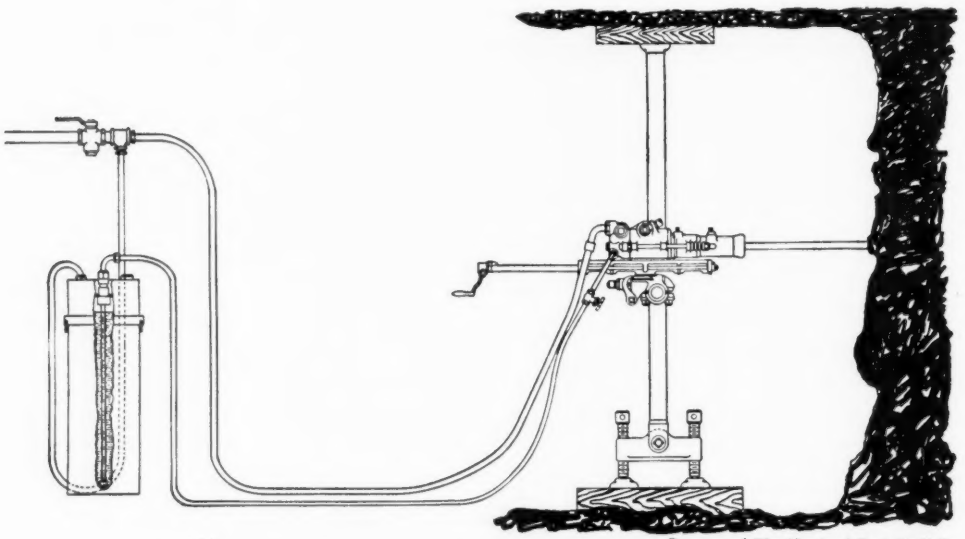
It will be evident from the above that there are both reciprocating and rotating elements to be considered in connection with the use of lubricants. Each present a somewhat different problem from the viewpoint of frictional wear.

It can be appreciated that the lubricant for the rotating parts must be such as to adequately lubricate with the least amount of internal friction and tendency to develop fatty acids. In consequence, lubricants for this purpose must be selected with the utmost care. Fortunately, due to the construction of the drill housing parts, there is but little possibility of dirt or grit entering the machine to contaminate the lubricant. These parts should, therefore, function for indefinite periods. As air, however, is the motivating power and is constantly being exhausted from the machine, a certain portion of the lubricant is being constantly carried out with the exhaust; the lubricant supply, must, therefore, be regularly renewed. Otherwise, there is but little possibility of impaired lubrication. One must, of course, remember that only very small quantities of



Courtesy of Worthington Pump & Machinery Corp.

Fig. 5—Details of the Worthington hand held rock hammer of the horseshoe valve type. "A" indicates the lubricator cap and other lubricating essentials, including the felt plug, plug spring and spring plunger.



Courtesy of The Cleveland Rock Drill Co.

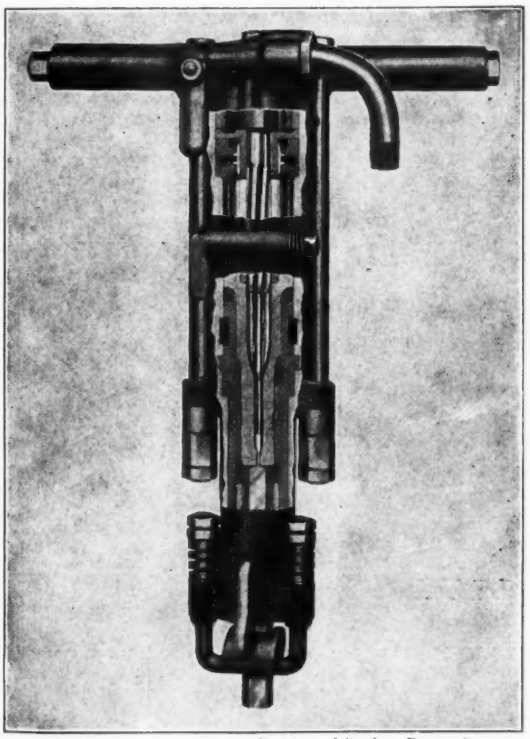
Fig. 6—Showing an arrangement of water tank and hose when used in connection with wet drilling operations.

lubricant are carried in the internal reservoirs of the average drill; hence frequent refilling is necessary. Larger reservoirs would necessitate more metal and heavier drills.

It is also practicable to lubricate the air prior to its delivery to the tool by means of a suitable air line oiler located in the air hose a few feet back from the drill. In addition, most rock drills have an internal built-in oil chamber and lubricating device. It is, however, not absolutely essential to use this inbuilt type of lubricator if the air line oiler is functioning properly.

OPERATING CONDITIONS

The rugged nature of the average drill often leads to a false impression in regard to the intricate mechanisms within. They are therefore often subjected to unnecessarily hard service, being thrown around or dropped regardless of whether they land in mud, slush, water or on rock. Handling in this manner will be found to result in more or less ultimate damage to the working mechanisms, even if the casing is

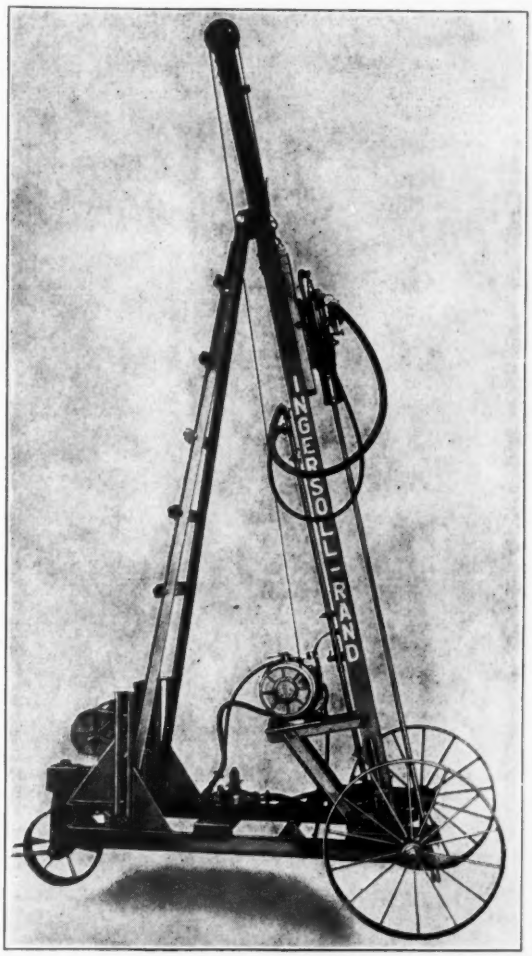


Courtesy of Gardner-Denver Company

Fig. 7—Sectional view of the Gardner-Denver S-55 hand held drill This device is also equipped with an integral oil reservoir.

rugged enough to come through whole. Furthermore, a certain amount of dust, dirt and water may frequently work in to rust, score or abraid the wearing elements.

It is relatively difficult for any lubricant to withstand such conditions, however suited it may be to the actual operating requirements. Water, for example, will tend to wash off the

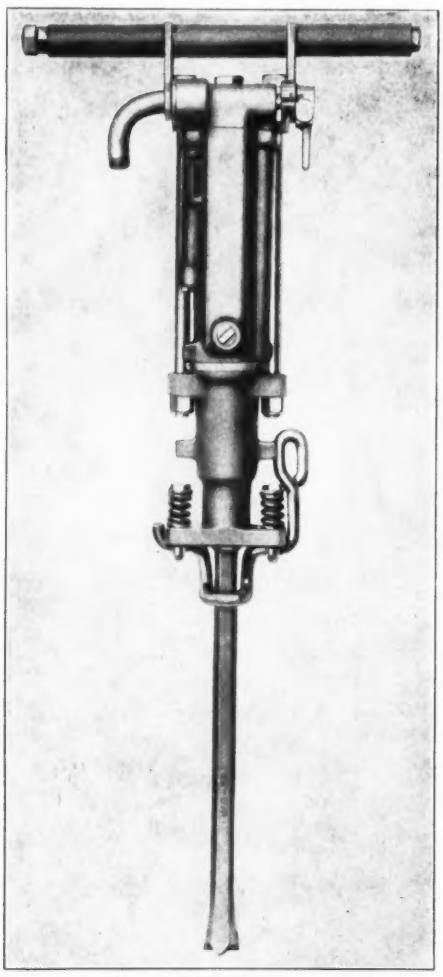


Courtesy of Ingersoll-Rand Company

Fig. 8—Ingersoll-Rand wagon drill. The mobility of a device of this type, and the extent to which the drill tower can be adjusted according to the angle of drilling, is noteworthy.

lubricating film from the wearing surfaces. For this reason, compounded mineral oils, of relatively high viscosity, containing more or less animal oil in compound are recommended for the lubrication of such equipment as hammer drills where they may have to operate in the presence of water. Such lubricants function on the same principle as do steam cylinder oils. In other words, they emulsify with water, by virtue of their fatty oil content, creating an adhesive emulsion which adequately resists the washing effects of water and sticks tenaciously to all wearing elements. But such lubricants are only recommended for air tools wherein water is entrained in the air due to atmospheric or operating conditions.

In tools of this nature, water leakage into the tool mechanisms must of course be prevented as far as possible. In fact, the conditions in the cylinders are somewhat similar to those encountered in the cylinders of pumps. In mine drills, this water may frequently contain an appreciable percentage of acid, which would cause corrosion as well as impaired lubrication in the body of the operating mechanism.



Courtesy of Worthington Pump & Machinery Corp.

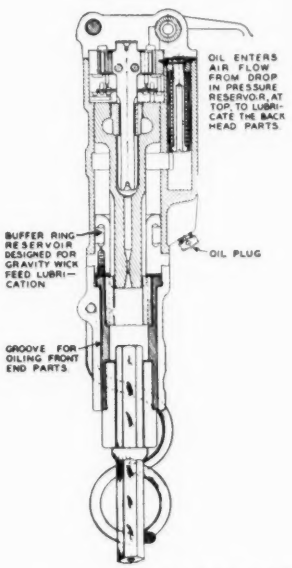
Fig. 9—The Worthington 3-Speed Rock Hammer. This drill is equipped with an inbuilt lubricator, with a readily accessible point for relubrication which is of material advantage in protecting the internal parts and the lubricant against contamination.

Where pneumatic tools are designed to function dry, they should be absolutely dry, and as free from moisture as possible. On such equipment, straight mineral lubricants are used. If they have been properly refined and are of the requisite viscosity and pour test they will withstand adequately any washing effect that may result from condensation of moisture from compressed air as normally used. They will not, however, protect the wearing surfaces against an excess of moisture as may occur if the tool is dropped in the mud or allowed to remain exposed to the elements for any length of time while not in use. The ultimate result will, of course, be rusting and corrosion, with subsequent difficulty in operation, an inability to perform the rated amount of work, and the necessity for repair or replacement of parts.

The Abrasive Effects of Dust and Dirt

Wherever a tool is carelessly handled, dust and dirt which may gain entry along with the dirt which may be carried through the tool by the air itself, will be detrimental as a potential cause of wear. It is normally easier to protect a drill against the entry of abrasive foreign matter via the tool itself than via the airline. All that is usually necessary is care in handling when not in actual operation. Rarely will any appreciable amount of dirt penetrate the tip orifice while air is passing through it. If it is therefore stored or rested in a position or locality free from dirt when not in use it should function satisfactorily for an indefinite period.

It is not always possible to obtain clean air, however, for this will depend upon the location of the compressor, its air intakes, whether or not air filters are installed, and the cleanliness of the inter-coolers and air lines. Furthermore, there will also be the possibility of particles of rust being carried along by the air, especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture.


OIL ENTERS AIR FLOW FROM DROP IN PRESSURE RESERVOIR AT TOP TO LUBRICATE THE BACK HEAD PARTS
BUFFER RING RESERVOIR DESIGNED FOR GRAVITY WICK FEED LUBRICATION
OIL PLUG
GROOVE FOR OILING FRONT END PARTS

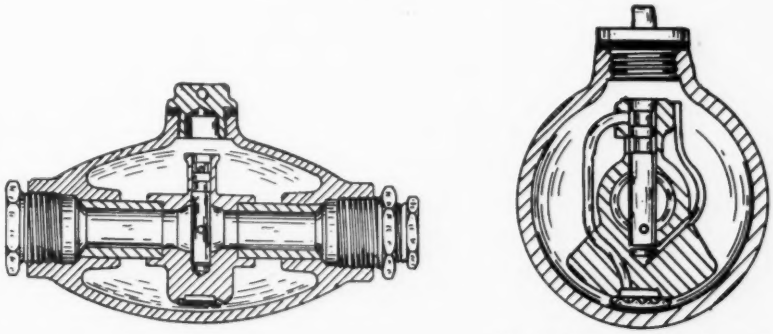
Courtesy of Sullivan Machinery Company

Fig. 10—Section through a Sullivan L-12 water tube type of drill. Points pertinent to lubrication are plainly indicated.

Particles of rubber from the air hose and gaskets may also find their way into the air passages and cylinders along with other foreign matter, to materially interfere with the free operation of the tool mechanisms.

For this reason, some authorities recommend locating a wire strainer of suitable fineness in the inlet pipe. This should effectively remove the greater part of any solid foreign matter and protect the working mechanisms of the drill. This strainer must be cleaned at frequent and regular intervals. Care in handling and delivery of lubricants to prevent entry of foreign matter will also be advisable.

Where automatic lubrication is provided for by means of air line oilers or atomizers which mechanically deliver the requisite amount of oil to the air lines, there will be the least possible chance of dust or dirt being carried in. Such devices literally lubricate the air, in much the same manner as mechanical or hydrostatic lubricators lubricate the steam in a steam engine. Air under pressure just like steam will readily carry and distribute properly atomized oil to all the working elements of the tool.



Courtesy of Gardner-Denver Company

Fig. 12—Details of the Gardner-Denver air line oiler. This device functions automatically while the machine is in operation. An ample supply of finely atomized oil is carried to all moving parts. When the air is shut off the oil flow is stopped. The rate of oil flow is adjustable and may be varied according to the viscosity and operating temperature. The principle of operation is based on drawing of oil from the reservoir by virtue of the partial vacuum which is created.

Courtesy of Sullivan Machinery Company

Fig. 11—The piston, rifle bar, ratchet mechanism, and buffer ring of the Sullivan L-9 Rock Drill. These operating mechanisms in any drill must be carefully designed and built of the best type of steel to insure positive operation, resistance to wear, and maintenance of adequate lubrication.

Where drills, hammers and other such tools must be periodically oiled by hand, however, in the absence of automatic means of lubrication, there may be more possibility of accidental entry of dust or dirt occurring. At best, operators' hands will be dirty, and in such localities as mines and quarries, the atmosphere will often be laden with dust. Under such conditions, the lubricants for current usage should always be stored and handled with the utmost care. Cases have been seen where these latter were kept in open cans adjacent to the tools, the only apparent idea being handiness and to eliminate loss of time when lubricating, as far as possible. Naturally, considerable dust and dirt will be bound to settle in these containers under such conditions with the result that the tools may be ultimately lubricated with an abrasive compound which will rapidly cause wear to a serious extent.

METHODS OF LUBRICATION

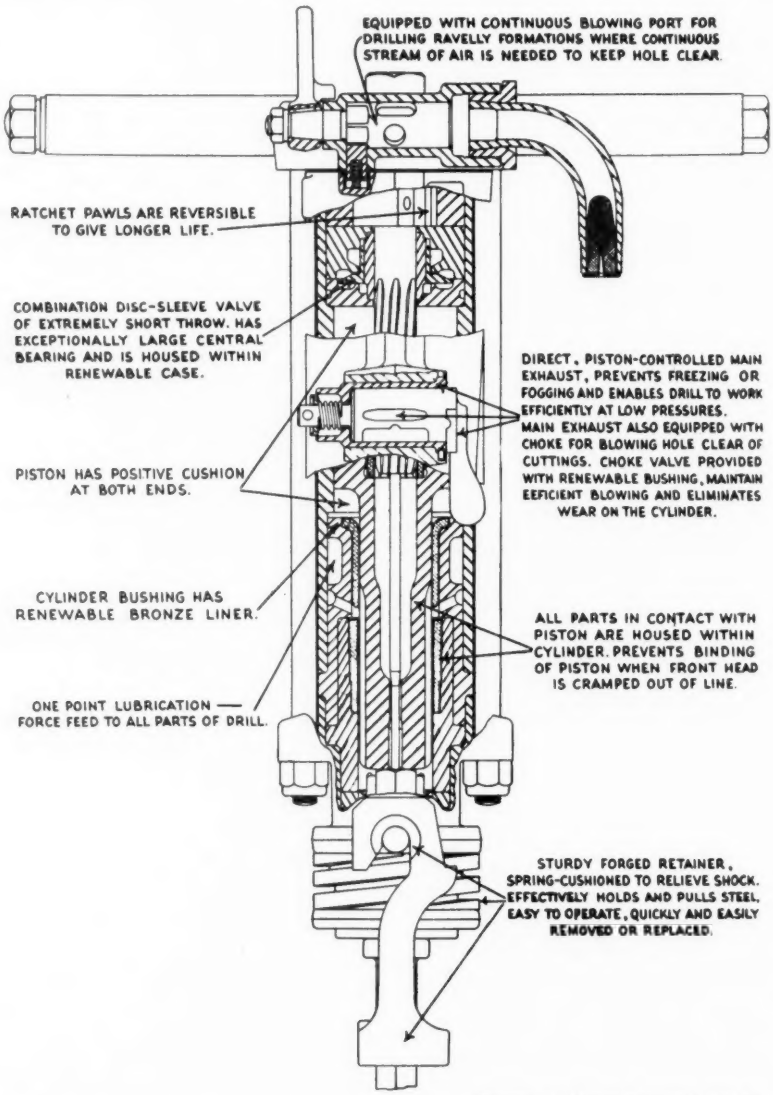
While the type and extent of refinement of the lubricants employed have much to do with efficient operation of pneumatic tools, the means whereby the former are applied or distributed has a marked effect upon their ability to function effectively. It is evident that even the best of oils or greases may fail to do their work if they are haphazardly used, in such a manner as to be unable to reach all the wearing elements of the tools. Tool builders will agree that perhaps more failures or complaints arise from ineffectual lubrication through misusage of lubricants, than from any average operating condition. In many cases, this will be due to ignorance; in others, how-

ever, sheer neglect is the reason, often because of lack of appreciation of the lubricating requirements of their equipment.

There are many excellent oils and greases on the market, in most cases refined more or less especially to serve pneumatic tools, with a minimum of fluid friction, a maximum of sealing power in the prevention of air blow-by past the pistons, excellent lubricating ability and a pour test commensurate with the operating requirements. It is obviously up to the operator to use these products intelligently, in accordance with the recommendations of the builders of his tools, and the oil company from whom he purchases. Makeshift or obsolete ideas may have been permissible in the past, today, however, the necessity for maximum production demands the adoption of the most modern means of lubrication, in the interests of continued and efficient operation.

Air Line Lubricators

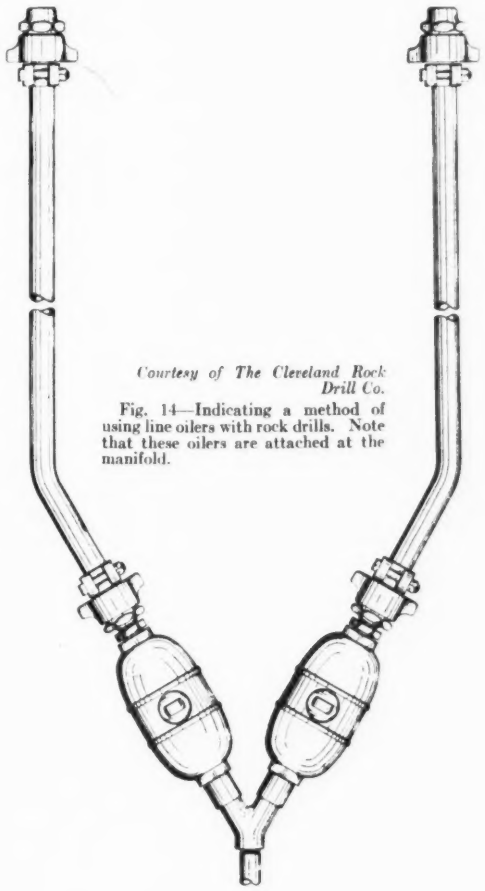
Devices of this type are in general intended for the handling of fluid oils. They work on the principle of atomization, pulsation or suction action. In the latter type, the air in its passage through the working mechanisms, draws the requisite amount of oil from the reservoir by suction. Where atomization is involved, there is a needle or pin valve through which a certain amount of air passes to carry the required lubricant forward into the tool.


EQUIPPED WITH CONTINUOUS BLOWING PORT FOR DRILLING RAVELLY FORMATIONS WHERE CONTINUOUS STREAM OF AIR IS NEEDED TO KEEP HOLE CLEAR.
RATCHET PAWLS ARE REVERSIBLE TO GIVE LONGER LIFE.
COMBINATION DISC-SLEEVE VALVE OF EXTREMELY SHORT THROW. HAS EXCEPTIONALLY LARGE CENTRAL BEARING AND IS HOUSED WITHIN RENEWABLE CASE.
PISTON HAS POSITIVE CUSHION AT BOTH ENDS.
CYLINDER BUSHING HAS RENEWABLE BRONZE LINER.
ONE POINT LUBRICATION — FORCE FEED TO ALL PARTS OF DRILL.
DIRECT, PISTON-CONTROLLED MAIN EXHAUST, PREVENTS FREEZING OR FOGGING AND ENABLES DRILL TO WORK EFFICIENTLY AT LOW PRESSURES. MAIN EXHAUST ALSO EQUIPPED WITH CHOKE FOR BLOWING HOLE CLEAR OF CUTTINGS. CHOKE VALVE PROVIDED WITH RENEWABLE BUSHING, MAINTAIN EEFICIENT BLOWING AND ELIMINATES WEAR ON THE CYLINDER.
ALL PARTS IN CONTACT WITH PISTON ARE HOUSED WITHIN CYLINDER. PREVENTS BINDING OF PISTON WHEN FRONT HEAD IS CRAMPED OUT OF LINE.
STURDY FORGED RETAINER, SPRING-CUSHIONED TO RELIEVE SHOCK. EFFECTIVELY HOLDS AND PULLS STEEL. EASY TO OPERATE, QUICKLY AND EASILY REMOVED OR REPLACED.

Courtesy of Chicago Pneumatic Tool Co.

Fig. 13—Structural details of the Chicago Pneumatic Heavy Sinker Drill designed for either dry or wet operation. All parts are clearly indicated.

In either case, air as it passes through the lubricator becomes charged with oil in finely atomized condition, to insure effective distribution to all parts of the tool with which it comes in contact.



Courtesy of The Cleveland Rock Drill Co.

Fig. 14—Indicating a method of using line oilers with rock drills. Note that these oilers are attached at the manifold.

Pulsation is also employed in the lubrication of air prior to its passage to the tool. Operation of such a lubricator is brought about by the reciprocating action of the piston, oil being kept thereby in continuous flow, to the air and tool mechanisms. Such a lubricator is frequently built with an oil capacity sufficient to last over a working shift in order to reduce the possibility of lack of lubrication through negligence or carelessness on the part of the operators.

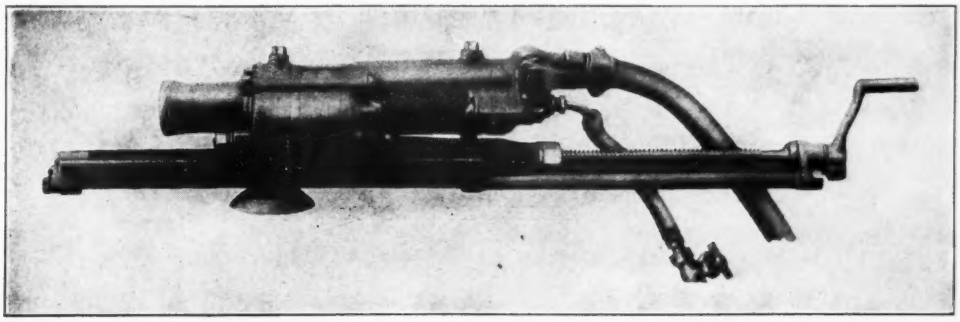
The valve chest lubricator operates by virtue of the pulsation of air in accordance with the movement of the tool piston within the cylinder. As a rule, such a lubricator is designed to handle heavier oils or light greases. Relubrication or re-charging is accomplished by means of lubricant-carrying cartridges inserted in the lubricator.

Chuck lubrication can also be mechanically effected on many types of tools by attaching a suitable device near the front end adjacent to the chuck parts. In certain types of such lubricators, ports are provided for carrying the lubricant to the impact end of the piston and chuck mechanisms. Grease is usually preferred for the lubrication of such parts, a grade of medium bodied product being adaptable to average operating conditions. Obviously, it must be resistant to oil separation, and stable with respect to oxidation.

THE BENEFITS OF CLEANLINESS

The fact that cleanliness is definitely allied to effective drill operation and dependable lubrication, requires the most careful consideration of the ways and means to accomplish the desired results and protect tool parts against normal wear, rust and corrosion.

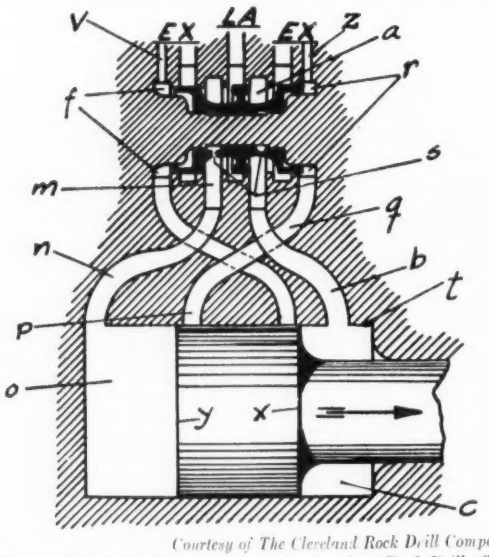
Cleaning can best be accomplished by using a solvent such as benzine, kerosine or gasoline. Normally, these will cut any gummy residues and enable them to be washed out. Where greases are used there will often be a tendency for accumulation of gummy residual matter. The entry of dust, dirt or water will aid in developing such formation, as well as adding an abrasive element. Such matter should, therefore, never become so extensive as to



Courtesy of Worthington Pump & Machinery Corp.

Fig. 15—The Worthington light heavy weight type of Drifter, designed for either wet or dry operation.

interfere with free motion of the tool mechanisms. Smaller tool parts can be effectively freed of non-lubricating accumulation by sub-



Courtesy of The Cleveland Rock Drill Company

Fig. 16—Illustrating the valve action of a Cleveland Rock Drill. The air enters at "LA", from whence it is distributed alternately to the opposite ends of the cylinder according to the movement of the piston. Vents "V" and "Z" permit air to escape to the atmosphere after it has done its work. Channels "b" and "m" serve alternately as supply and exhaust ports.

mergence in a bath of any one of these cleaning fluids for a few hours, and blowing out thoroughly with air.

Large tools, however, may require disassembling to a more or less extent when cleaning is necessary. If the tool has been laid up for any length of time, the parts should be soaked in solvent to soften or cut any gummy matter and permit of easy washing off of such other foreign residuum which may not be entirely soluble.

An effective way of preventing accumulations of foreign matter in rock drills is to suspend them in a bath of cleaning fluid whenever they are not in use. This will prevent oxidation by eliminating contact with air, otherwise, were the latter at all moist, it would promote the formation of rust, corrosive matter and gummy residues from certain classes of lubricants. Immersion, therefore, is an excellent preventative against oxidation. Prior to re-usage, however, the tool should of course be thoroughly re-lubricated with fresh oil or grease according to its requirements.

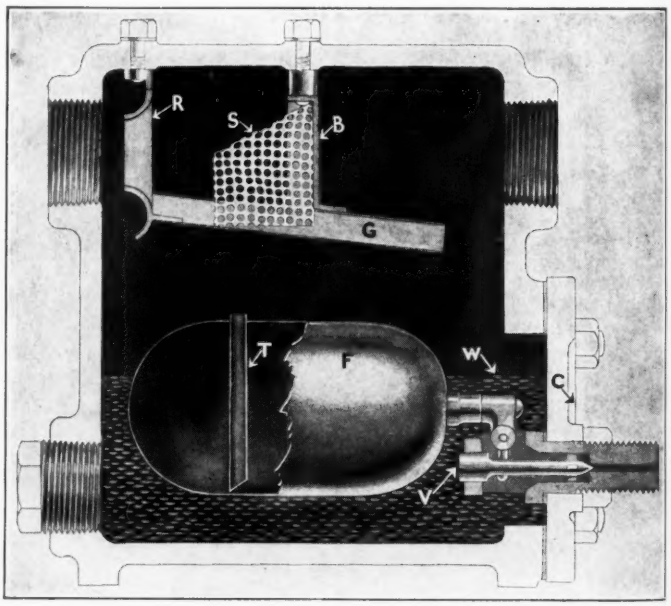
LUBRICATING REQUIREMENTS

In studying air tool lubrication one must consider three distinct types of lubricants. Normally these will include those compounded cylinder oils as required for tools wherein moisture is present; the conventional low pour point and light viscosity straight mineral oils; and light to medium bodied greases adaptable to heavy slow moving tools or parts designed for grease lubrication. Oils are in general required for valve and cylinder lubrication of higher speed tools, for conditions where water or excessive moisture may be involved, and in some cases for the lubrication of the chuck parts and impact end of the piston.

Pour Point an Indication of Low Temperature Fluidity

The behavior of a lubricating oil when subjected to low temperature conditions has led to considerable study of methods of test, to determine accurately the point at which congealment begins and fluidity becomes retarded. In the interest of effective lubrication at low temperatures, this knowledge becomes of considerable value in initial selection of oils which will possess adequate fluidity to enable ready handling in lubricating devices, and maintain protective lubrication of the parts to be served.

The effect of cold upon petroleum lubricating oils is not the same as upon simple fluids, such as water, alcohol, glycerine, benzine, etc. The latter have fixed and accurately ascertainable freezing points at which a complete change



Courtesy of New Jersey Meter Company

Fig. 17—The "DriAir" separator which automatically ejects condensed water from compressed air lines, and collects rust, pipe scale and other foreign matter. Wet air enters at the left, meeting ring baffle "R". This deflects heavy slugs of water throwing same outward against the wall of the cylinder and downward into the collecting space at the bottom. Any other water is collected at screen "S" and directed to the bottom by gutter "G". Below this gutter is shown the mechanism for automatic ejection of water.

from the liquid to the solid state takes place, but lubricating oils, which are mixtures of hydrocarbons of various melting points, or freezing points, behave like solutions, and frequently deposit some portion of their constituents before the whole mixture solidifies.

Interesting phenomena which can only be explained by change in the inner or molecular structures are observed in the pour test of many lubricating oils.

The A.S.T.M. (*) defines the pour point as follows:

> "The pour point of a petroleum oil is the lowest temperature at which the oil will pour or flow when it is chilled without disturbance under definite prescribed conditions."

Stirring is contrary to good practice, for where an oil is stirred, it solidifies at a lower temperature than when held stationary. This may be explained on the assumption that the movement of the oil destroys the formation of a fine network of microscopic particles of paraffinic bodies which are separating out.

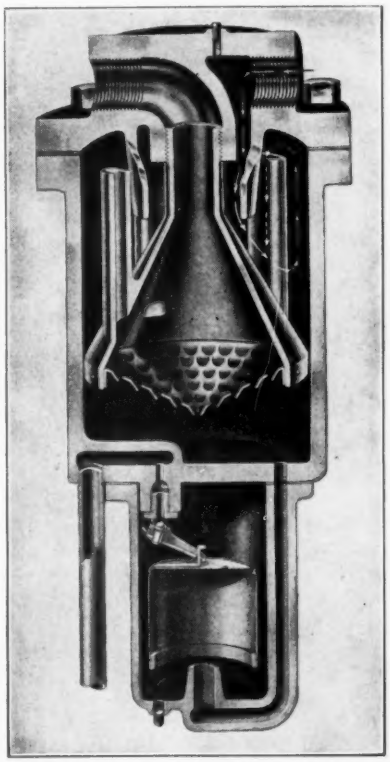
This segregation gives the oil a certain support and thereby facilitates solidification. In an analogous way this explanation may apply to the influence of pre-heating; the waxy particles being probably transformed by warming into a very strongly dispersed state, from which it is possible to form a finer and thicker network than in the oil which has not been heated.

Their opinion (†) as to the significance of this characteristic is also of interest, viz.:

> "The pour point gives an indication of the temperature below which it may not be possible to pour or remove an oil from its container, or below which it might be dangerous to use the oil in gravity lubricating systems, where the head tending to produce flow is small. However, it should be borne in mind that the size and shape of the container, the head or force exerted upon the oil, and the nature of its physical structure when solidified, all have an effect upon its tendency to flow. Accordingly, it is self-evident that no single test can be devised which can be taken as a positive and direct measure of the performance of an oil under all conditions of service, and the pour test should be regarded as giving only an indication of what may be expected."

Courtesy of Gardner-Denver Company

Fig. 18—Cylinder details of the Gardner-Denver hand held drill. This cylinder is fitted with a removable bushing which is designed with an angular groove constituting an oil reservoir of considerable capacity.



Courtesy of The Direct Separator Co., Inc.

Fig. 19—A combination air separator and trap for removing oil and water from compressed air. A device of this type is extremely advantageous where clean dry air is essential to operation.

Viscosity

Due to the fact that the viscosity is one of the most practicable guides to the pneumatic tool operator, in regard to the adaptability of an oil for the conditions under which he must operate, he must be thoroughly familiar with this characteristic.

For the information of those not fully informed in this regard, it is well to state that viscosity is that inherent property by virtue of which the flow of liquids is retarded. It is therefore possessed by all oils in varying

(*) A.S.T.M. Method of Test for Cloud and Pour Point, D-97-34, A.S.T.M. Standards on Petroleum Products and Lubricants, Sept. 1935, p. 47.

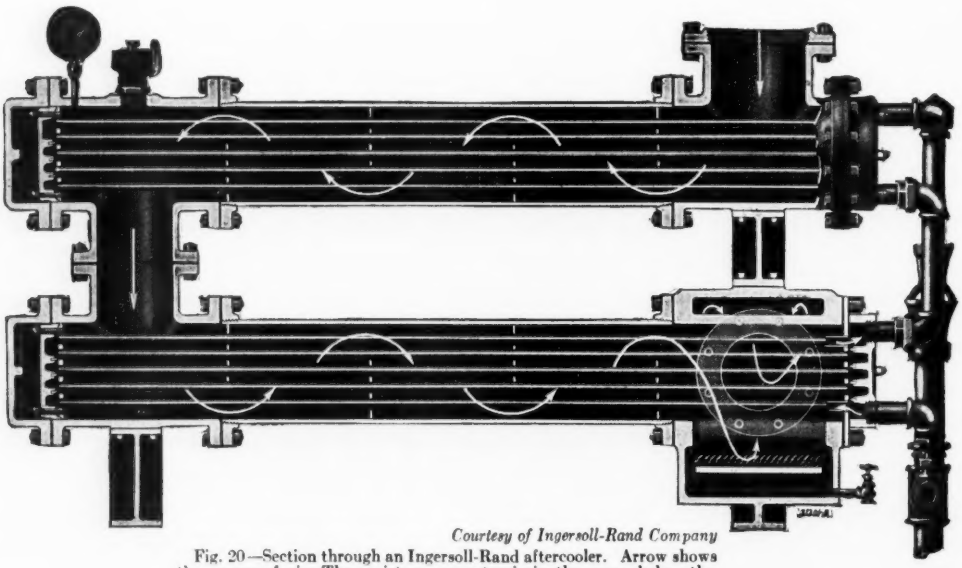
(†) The Significance of Tests of Petroleum Products, Report of Committee D-2 on Petroleum Products and Lubricants, 1934, p. 9-10.

degrees. In effect, it is the resistance offered by the particles or molecules of a liquid in sliding past each other.

Viscosity is commonly measured by taking the time required for a certain quantity of the liquid in question to flow through an orifice of standard size under standard temperature conditions. The Saybolt Universal Viscosimeter has been adopted for this purpose by the American Society for Testing Materials. In the oil industry. it constitutes the measurement of the number of seconds required for 60 cu. cm. of oil to flow through the orifice at the standard temperature. For lighter products such as engine and machine oil, this is usually 100 degrees Fahr. For heavier oils, such as gear compounds and steam cylinder oils, 210 degrees Fahr., is commonly used. Therefore, when an oil is referred to as having a Saybolt Viscosity of 300 seconds at 100 degrees Fahr., it implies that 300 seconds will be required for 60 cu. cm. to flow through the standard Saybolt viscosimeter at this temperature.

power medium should not come in contact with any water other than the small amount which will be condensed in the air lines during passage from the compressor to the drill. Due to the gradual cooling which takes place within these lines, it can generally be assumed that all air, as involved in rock drill operation, contains moisture, the amount depending upon the temperature. When condensed, a large part of this moisture will tend to precipitate and form water, as mentioned above. Of course, if it is not removed it will follow a course through the air lines. In addition, water in rock drill mechanisms will wash away the lubricant and impair the operation of the tool parts, and tend to loosen scale, rust or dirt in the pipe lines, which would obviously lead to serious consequences were foreign material of this type carried through the working elements of the tool with the air.

It is practicable to remove moisture of this nature by means of a suitable aftercooler



Courtesy of Ingersoll-Rand Company

Fig. 20—Section through an Ingersoll-Rand aftercooler. Arrow shows the course of air. The moisture separator is in the space below the right hand end of the lower tube nest.

MOISTURE REMOVAL

As has already been mentioned, there are certain detrimental features attendant to the use of abnormally wet air in rock drill operation, for the moisture content in this air may not only interfere with circulation and performance of the lubricant, but also this moisture content may freeze at the exhaust port and reduce the effectiveness of the drill; moisture in the air will, of course, tend to cause rusting and corrosion of certain of the tool parts.

In a well designed drill, the air used as the

installation in conjunction withthe compressor system. Where an aftercooler is not in use, however, a moisture separator can be used to good advantage. Any device of this sort can be installed on branch lines or outlets. One must, however, consider the prevailing temperature within the trap. Where this may become abnormally low, with the possibility of freezing of the water content, frequent draining must be assured; otherwise it would be best to install the separator in the compressor room or in some other warmer compartment where there will be no possibility of freezing.

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Don't let OIL leave its calling card CARBON

Here's how you can reduce compressor hazards with minimum feed and low-carbon oils

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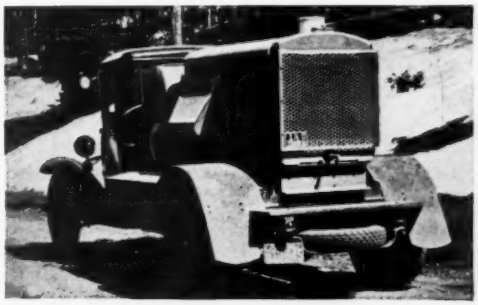
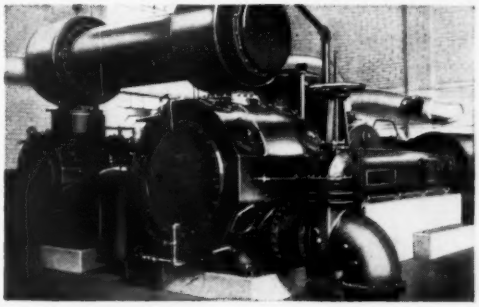
Write The Texas Company and we will send our representative to serve you.



The portable compressor is a rugged individual. It has to be, because the hazard of dust is added to the "natural causes" of compressor trouble.



Even in these large stationary compressors, carbon will form if the lubricant is not right. Operators of compressors such as these find that Texaco Compressor Oils give them safe, economical operation.

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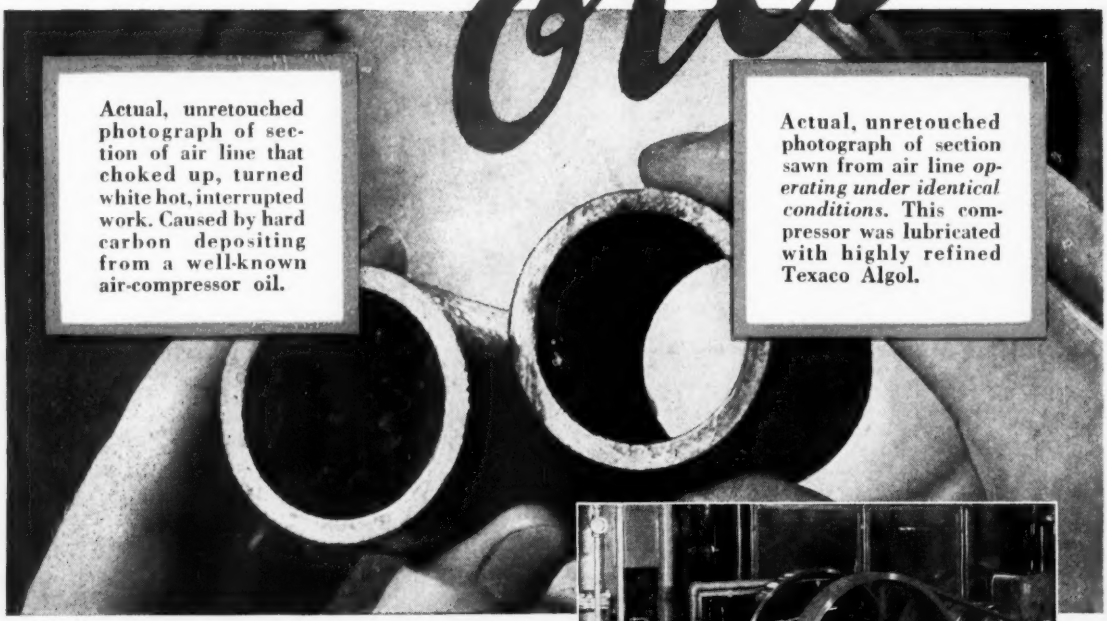
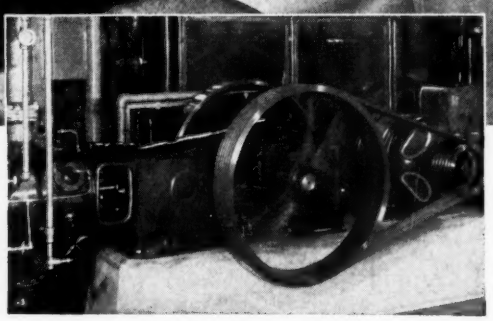

Actual, unretouched photograph of section of air line that choked up, turned white hot, interrupted work. Caused by hard carbon depositing from a well-known air-compressor oil.
Actual, unretouched photograph of section sawn from air line *operating under identical conditions.* This compressor was lubricated with highly refined Texaco Algol.



An air line became white hot.

Right next to it, on the same job, another air line was working perfectly.

The boss ordered both compressors shut down.

"Get a hack saw and cut me out a section from each line," he ordered.

The line that had heated up so dangerously was found to be completely clogged . . . *packed tight with carbon hard as flint.*

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That is the difference oil can make in your air-compressor equipment.

Oils may look alike, but . . . Texaco Cetus, Alcaid and Algol Oils are refined by a special process to make them *right* for compressors. They have the extreme purity that is absolutely necessary to *safe* compressor operation.

They *cannot* form hard carbon that chokes up your air line.

They form only a slight amount of carbon, and this carbon is so light and fluffy in nature that it *blows right out through the air line.*

Specify Texaco Cetus, Alcaid or Algol. In many cases, the extra purity of these oils will *reduce the rate of feed* materially.

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